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UNIVERSITY OF ALBERTA

Economic Analysis of Fibre Production From Private Forest Land in Alberta

by

MARK MESSMER

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

IN

FOREST ECONOMICS

DEPARTMENT OF RURAL ECONOMY

EDMONTON, ALBERTA

SPRING 1990

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The undersigned certify that they have read and recommended to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled Economic Analysis of Fibre Production From Private Forest Land in Alberta submitted by Mark Messmer in partial fulfillment of the requirements for the degree of Master of Science in Forest Economics.

William E. Phillips

Diana M. Boylen

Date: February 28, 1990

ABSTRACT

The availability of fibre from private land in Alberta has been largely ignored. This is due mainly to a surplus of fibre from public land. However, much of this surplus has been allocated in recent years, so that fibre from private land is quickly becoming a potentially important wood supply for primary forest products firms in Alberta.

This study concentrates on obtaining information from land owners in west-central Alberta. A market is presently available for a certain amount of fibre from private land in this area. The information from thirty-eight land owners was obtained with a personal interview survey conducted in May of 1989. Respondents were asked questions on the physical characteristics of their land, production costs from harvesting, questions related to their socio-economic conditions, and uses of their forest land.

In addition to a descriptive presentation of the survey results, the study includes the use of a model to evaluate the relative importance of certain variables as they may affect a land owner's decision to supply fibre now, and in the future. The responses from land owners that have supplied fibre, and those that have not were used in this analysis. The results from this modelling exercise show that land owners are particularly responsive to price, the amount of merchantable timber they have,and net returns from harvesting in deciding whether or not to supply wood

in the future. Variables such as size of forest, presence of a management plan, and others, were not significant in predicting the supply choice variable.

A discussion of market structures for private fibre is presented. The presence of transactions costs to both land owners and firms in procuring private fibre are important characteristics of the market, and as such are analyzed in light of the modelling results. It is concluded that land owners' decisions to supply fibre can be influenced by policies that offset these transactions costs. Further conclusions illustrate how these market structure elements and the modelling results can be used to guide policies toward forest land owners.

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CHAPTER I

INTRODUCTION

A. Introduction to the Study

The use of private land for the production of fibre has received almost no attention in Alberta, due to the fact that public land has always produced a surplus of timber, and private land in rural areas is generally owned and invested in for its potential to produce agricultural products, and recreational amenities. The amount of privately owned forest land in Alberta has been estimated to be 933 000 ha.. This is about 4.3% of the total amount of productive forest land in Alberta (Forestry Canada, 1988).

Land settlement history in Alberta however, has shown the importance of existing stands of forest as a source of wood products. Most rural land owners in the west central area of the province where forest land exists, recognize the importance of maintaining some degree of their land base as forest, for both consumptive uses, and for maintaining environmental quality (James, 1988). Traditional uses of the forest for fibre supplied local markets with some bulding supplies, and fuel. Increasing specialization and technological changes in agricultural production have allowed the land owner to become less self-sufficient in wood products. Today, some small

sawmills established during the time of settlement are still operating. These have always relied to some degree on privately owned wood supplies, however, their relative economic importance has diminished with the advent of large industrial wood products enterprises. Land owners that live within the economic wood supply areas of these new industries may now become a part of their potential future wood supplies in recent years. This has helped to create a shift from personal to market destinations for their fibre.

This potential for private land owners to supply fibre to the large firms, and the complete lack of economic information on how land owners may be affected, supports the need for collecting and analyzing economic data on private forest land owners.

B. Background

Historically, forests in Alberta were viewed as obstacles to agricultural development. To a large degree, this holds today since much of the standing timber on land converted to agriculture has been piled and burned (James, 1988). Private markets do not appear to recognize the value of standing timber on private land. In order to determine the validity of any market failure argument for the inability to realize these timber values, one must consider the relative prices of land for other uses. As well, changes over time in these relative prices, and the price if wood must also be considered. However, such a complete

marginal analysis is not the purpose of this study. The task is more narrow in focus. The present study will examine land owner characteristics, and supply behaviors as they exist under present market conditions for fibre from private land.[1]

With only a very cursory analysis of the amount of privately owned forest land in Alberta that does not include standing forest in designated agricultural areas, it is difficult to speculate on the amount of mechantable fibre available. Only very crude estimates of the area of private forest land in Alberta have ever been recorded[2]. There are no estimates of fibre inventory on private land of either a biophysical, or merchantability nature, although a study has recently been commissioned by the provincial government to determine this inventory. Both Eastern Canada and the United States, where private fibre supplies are of greater economic importance, have been studied extensively with respect to both available private wood supplies and their relative importance to industry and

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[1]For more information on resource pricing in Alberta, refer to the Forest Act, and individual Forest Management Agreements with Alberta industries, as well, more precise descriptions will follow .

[2]See Forestry Canada, 1988. Canada's Forest Inventory, 1986.

land owners. Many of these studies will be used to as a basis for estimating the relative economic importance of private forest land in Alberta.

In Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island, the economic importance of fibre from private land can be attributed to several factors. These are the greater amounts of economically available private versus publicly owned fibre, the higher values placed on wood in the market, and the historical settlement of agricultural land that includes private woodlots. These have become established, long term sources of fibre (Huber, 1985; Curtis, 1988). None of these factors exist in Alberta, although this may soon be changing, as some evidence of this change is apparent (James, 1988).

For this study it was necessary to collect information from owners of forest land. The requirement of detailed data on land owner's harvesting experiences and behaviors, led to the conduct of an intensive personal survey concentrating on land owners living within an economic wood supply zone. The wood supply zone chosen for the study area is the only area of the province at present where a relatively large number of land owners actively sell wood to a large processing firm. The survey was concentrated on those land owners that have harvested wood products from their land. This was done at the expense of collecting less data on those landowners that own merchantable timber, but have never harvested any of it. Further survey description

has been given in Chapter III.

In the chosen study area of west-cental Alberta, a new market for fibre has been created. In 1983, a private company, (Pelican Spruce Mills, Ltd.), began producing oriented strand board, a nonstructural panel product made from waferized aspen (*Populus tremuliodes*). Since then, a plant of similar scale was built in 1987 by the same company in Drayton Valley. A new bleached chemi-thermomechanical pulp mill Whitecourt has begun to use aspen in their furnish. A new newsprint mill planned for Whitecourt will also use aspen.Future plans for Alberta's forest industry will continue to rely mainly on public (Crown) land to supply fibre. New projects are always provided an allowable harvest, consistent with the government's long run sustained yield policy[3]. However, the location of these industries near Alberta's forest/agricultural land borders, and the relatively close proximity of these mills to private forest land along this border could help to make private forest land an economically attractive wood supply for firms.

Although the recent emphasis on fibre demands from private land in Alberta has centered on aspen, historical demands have been on softwoods as most hardwood fibre was considered unmerchantable until recently. As forest industries become established in Alberta, and utilize much

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[3]See Alberta's Forest Act, 1978.

greater quantities of aspen, increasing opportunities will be available to owners of forest land to market their merchantable fibre. The present annual harvest of hardwoods and softwoods in Alberta is 0.6 million m3 and 7.9 million m3 respectively. An additional 6.7 million m3 of hardwoods and 3.6 million m3 of softwoods have been allocated for new industry expansion (Woodbridge,Reed, and Associates, 1988, vol.5 pp.15). A significant portion of the economically available fibre could come from private forest land.

The amount of fibre from private land could be influenced by four potential sources of market failure. First, it is possible that the exercise of monopsony power by firms leads to timber prices that are too low to warrant harvesting. Second, the small volumes of wood available from this source and the apparent lack of a sustainable supply may make this timber less attractive to firms. Third, transaction costs to firms in having to deal with many small parcels of timber versus the cost of dealing with the government in obtaining larger, relatively secure wood supplies at costs that basically set the stumpage price private land owners can expect to receive, could be a barrier. Fourth, the costs to the land owner of managing relatively small areas of forest land may be prohibitive. As well, obtaining information on how to optimally manage forest land, and information on available markets for products, may also involve transactions costs that are prohibitive. Obviously, discriminating among these

competing hypotheses is very difficult. Nevertheless, the role of market structure must be considered in the analysis to come.

C. Objectives of the Study

The central problem of this study is to identify the determinants of individuals' behaviour with regard to timber harvesting from their forest land. The extensive amounts of information about private forest land ownership that exists for other areas of Canada, Europe, the U.S.A., and other parts of the world may not be suitable for extrapolation to Alberta because of differences in land ownership patterns, market structures, and institutions. However, some comparisons are drawn between the policies of Alberta's forest industry, the Alberta government, and these other areas of the world as they affect forest land owner's utilization decisions.

In order to provide a basis for which we can consider acting on any market failure hypothesis, it is first necessary to collect and examine information on land owners' harvest decisions. This will provide guidance in answering the following questions:

1. How important are fibre production objectives in the ownership of forest land?

2. What opportunity costs are there inherent in managing forest land for fibre production?

3. What are the values and ranges in production costs

for fibre from private forest land, and what have land owners experienced in this regard?

Providing answers to these research questions will help us address the following issues:

1. To determine if both qualitative and quantitative variables measured in a survey of west central Alberta land owners will provide significant information in determining a forest land owner's decision to supply roundwood in the market.

2. To provide a likely scenario of the market structure for land owners who are sellers of roundwood and firms who are buyers of roundwood, based on a theoretical model and its application to other areas of the world.

The structure of the thesis is as follows. Chapter II reviews the existing literature on private timber market structures in other parts of Canada, and the world. From this review of the literature, it is possible to describe the basic market structure facing Alberta forest land owners. Chapter III describes the data collection methods, and the results from a personal interview survey of 38 land owners in west-central Alberta. Information was obtained on physical characteristices of the land holdings, production costs of harvesting and land rents from other

land uses, and social and economic characteristics of the land owners. Chapter IV describes the theory and methodology used to assess the determinants of the timber harvesting decisions of land owners. A logit model and ordinary least squares model are used to estimate and assess the influences and conditions relevant to forest land owners' decisions to supply roundwood. Chapters V and VI contain analysis and discussion of the results and conclusions respectively, from the models and their implications for provincial forest management policy, and future research.

CHAPTER II

THE STRUCTURE OF MARKETS AND INSTITUTIONS FOR FOREST LAND OWNERS

A. Background

Most primary forest products firms in Alberta share the feature that they are geographically isolated from each other. This is generally because of the desire to locate near a wood supply. The size of land area required for a given wood supply and the limitations of transportation cost constraints, are such that there are definite limits on the number of firms of minimum efficient size that can locate in a given area. In Alberta moreover, the sustained yield harvesting policy that regulates the harvest and its allocation from public forest land that supplies the vast majority of industrial roundwood certainly reduces competition between firms for the same wood supply.

The establishment of long term tenures in Alberta such as quota certificates and forest management agreements that allow for sustainable wood supplies to large firms has further eliminated competition for wood supply.[1] The

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[1]For a complete description of long term tenure available to large firms in Alberta refer to the Forests Act, Timber Management Regulations.

presence of competition for wood supply is difficult to assess given the lack of current and readily available information on how much of Alberta's wood supply is economically accessible. However, the level of recent investment by new forestry firms in the province suggests that a fair portion of it is.[2]

The competition for wood supply from private land may become more acute than for wood from public tenures for Alberta firms. Private land wood supplies in Alberta have the advantage of built-in infrastructures. Alberta firms must assume the costs of road construction to access timber on public land .

These aspects of competition for private wood supplies will be analyzed in the context of the following theoretical background of market structures.

Johansson and Lofgren, (1985) described the general nature of the Swedish roundwood market for pulpwood.[3] It is characterized by buyers that have a spatial monopsony or oligopsony power, and sellers that have, to differing degrees of success, organized to counteract this power. This has developed into a number of bilateral monopolies,

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[2]New forest investments in Alberta from 1989 to 1995 are projected to be approximatley $3.5 billion in new processing capacity.

[3]See also Lofgren 1984, and Brannlund, 1987.

where essentially one seller faces one buyer. Five price regions can be identified in Sweden, and within each, prices for roundwood are negotiated annually between firms and land owner organizations. Roundwood can also be purchased from private holdings owned by the firms themselves, imported, or obtained from other regions of the country. Johansson and Lofgren (1985)also note that during the late 1970's many industries owned by land owner associations had considerable finanacial problems, which caused them to keep roundwood prices low. As a result, land owners in these associations began to look elsewhere for other firms that offered premiums for roundwood. Many of these land owner-owned industries were purchased by other companies or vanished, due in large part to the inability to obtain wood from their land owners. This suggests that the degree of monopsony or oligopsony power for Swedish firms is relatively large. Brannlund (1987) notes however that monopsonistic price setting behavior has been used as an assumption, and not as an hypothesis. This assumption is based on what he calls a "soft test" of the investigation of Swedish industry and purchasing organizations that does not refute the assumption of monopsony.

Clawson (1979), in an extensive study on the state of U.S. small forest land owners notes that there is almost a total lack of information on prices paid for stumpage on a national scale that adequately reflect differences in qualities and kinds of roundwood. He compares this dearth

of information to the relative availability of detailed, frequent, and localized information for agricultural commodities. From his analysis of the characteristics of U.S. markets for wood from small land owners, he concludes the following:

1. The bargaining strength of timber buyers is generally greater than that of timber sellers.

2. Many timber industry firms are characterized by some degree of oligopsony or monopsony power in roundwood markets.

3. Larger firms may have greater long term interest in a given timber supply such that they will fail to completely exploit any monopsonistic advantage they have.

4. Many land owners use their timber supply as a financial reserve, only to call on it when they are least able to afford the time and effort to search for the best price.

5. The wide range of variability in forest stands, combined with the degree of variability in the productivity of forest firms and the degree of variability in reporting actual prices paid for stumpage in different areas of the U.S. has undermined and will continue to undermine the ability to determine the relative degrees of buyer's and seller's powers in the market for roundwood.

Other literature describing the market structure for roundwood among private land owners in the U.S. appears quite scarce. Binkely, (1983) notes that aside from the

fact that U.S. data on National trends in forest land ownership are highly aggregated and often contradictory, any empirical understanding of the operation of markets for roundwood from small land owners is very poor. Boyd and Hyde, (1989) make brief reference to some effects of U.S. stumpage market price variations on firms and land owners. They suggest that greater market power exists for firms versus land owners. With such oligopsony power, firms are able to transfer some of the final product demand price variation they receive to prices paid for roundwood from land owners. They suggest that this is also in part due to land owners' lack of sufficient information on roundwood prices. The nature of almost all other U.S. literature dealing with economics and private forest land owners relates to the efficacy and efficencies of government assistance programs. Small forest land ownerships in the United States are referred to as nonindustrial private forest lands (NIPF). The U.S. has a long history of technical and financial assistance programs for NIPFs and some of the reasons for this are as follows.[4]

The belief that market failure exists in stumpage markets is long standing, and has led observers to argue that a future timber shortage can only be avoided if government financial incentives aimed at increasing the wood supply are promoted. However, the claim of a timber

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[4]Boyd and Hyde, 1989; Binkely, 1983; Max, 1983.

shortage is less popular today. A market failure argument is now used instead. It arises from the failure of the market to take into account non-timber benefits, as well as the transactions costs to firms and owners of forest land. Boyd and Hyde (1989) consider the timber supply shortage claim to be an unlikely scenario, and the market failure argument to be more prevalent. A second argument is that the small size of landholdings and the rural location of ownerships may imply that landowners are less well off than average. As such they should be eligible for redistributive gains from government forestry incentives programs.

From the analyses of these American experiences it can be seen that justifications for NIPF assistance programs in the U.S. imply that there can be significant transactions costs involved for owners of relatively small areas of private forest land that choose to become part of the wood supply. However, this is not always the case.

Over the last ten years, a considerable amount of information has been documented with regard to the structure of roundwood markets for private land owners in Eastern Canada; namely Ontario, Quebec, New Brunswick, Nova Scotia, and Prince Edward Island. In a report prepared for the Canadian Forestry Service, (now Forestry Canada) Curtis (1987) provides an extensive descriptive analysis of forest land owner organizations in Eastern Canada. These organizations included cooperatives, corporations, group ventures, marketing boards, and federations. The history,

purpose, and relative successes and failures of virtually all land owner organizations was presented, rather than an economic analysis of the market structure inherent in each province. There are a number of purposes for most of these organizations but most were formed to act as bargaining agents with firms, in order to counteract either perceived or existing monopsony power. The success of these organizations would seem to depend on some of the following factors:

1. The level of interest that land owners have in selling roundwood.

2. The degree of economic importance a given area of land owners represent with regard to the wood supply.

3. The relative amounts of buyer's and seller's powers in the particular market.

Provincial governments in Eastern Canada have provided financial assistance to many forest land owner associations, with considerable variations of success. In Prince Edward Island, for example, most organizations were initiated by government, but have generally failed due to a lack of motivation on behalf of landowners to take leadership roles in the organizations, and a general lack of understanding on behalf of land owners of potentially available market opportunities (Curtis, 1987). Forcing land owners to create organizations without first establishing that their welfare will be improved by doing so is thought by Curtis to be the main reason for their demise.

A report conducted by the Ontario Ministry of Natural Resources (1982) provided considerable descriptive information on a 1981 survey of 12,400 rural land owners. The study does not discuss either the economic significance of private forest land ownership or the structure of roundwood markets for land owners. Results from their survey suggested most forest land ownership is incidental to agricultural operations and provides fibre for supplementary income. However, since 1982, the pulpwood market's new-found appetite for hardwoods may have altered the economic importance of Ontario's private forest lands that are are predominantly hardwoods (45%, hardwoods, 15%, conifers, and 36% mixedwood).

The role of governments in providing assistance in the form of marketing, management, and education in eastern Canada would appear to have had both successes and failures, but the relative importance these governments place on their roles in forest land owner assistance is far less than that which appears to be the primary focus of attention in the United States.

B. A Theoretical Model of Roundwood Markets

As previously mentioned, when a wood supply is distributed among a large number of relatively small sellers, and buyers can exploit a spatial monopsony (or oligopsony) due to transportation cost constraints that inhibit the interregional trade of roundwood, then it is

possible to illustrate that both the output and price of roundwood will be lower than what would occur under a regime of pure competition. The following has been adapted from Johansson and Lofgren, (1985).

q = the quantity of wood delivered from each land owner, and Q = the total quantity of wood from all land owners.

The buyer (monopsonist) faces the following supply function:

$p=p(q)$, where $\delta p/\delta q \geq 0$, and p= the delivered wood price at the mill gate.

The supply price of delivered wood is a non-decreasing function of the quantity. Making the assumption that all other variable inputs are fixed does not affect the results, and thus the following production function:

$Q = f(q)$

The objective function for the buyer of wood allows for the maximization of profit:

$\Pi = P*f(q) - p(q)*q$

where P is an exogenously determined output price of the final wood product.

The first order conditions for the above objective function are:

$P*f(q) - (p + q*\delta p/\delta q) = 0$

where: $f = \delta Q/\delta q$ = marginal product of delivered wood.

At the optimum, the value of the marginal product of delivered wood is equivalent to the marginal outlay of delivered wood. Figure 1.0 below illustrates this point:

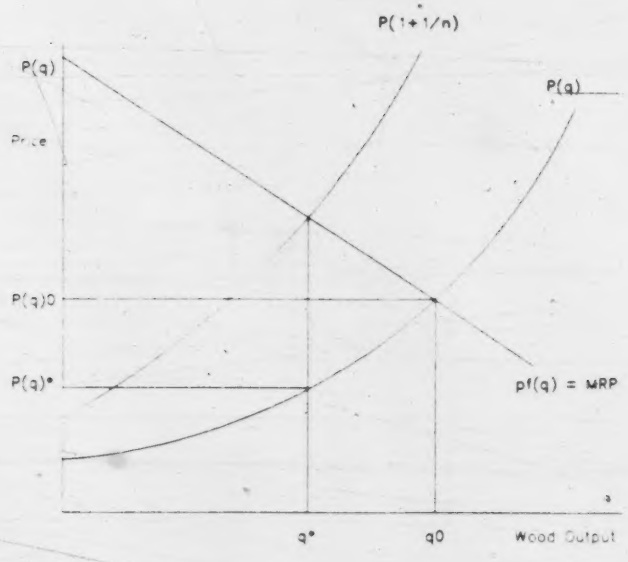

Figure 1.0 Equilibrium in the monopsonistic roundwood market

In the above figure, n, equals the supply elasticity in the delivered wood market:

$n = \delta q/\delta p * p/q$

The demand for delivered wood for any supply elasticity less than infinity ($n < \infty$) will not be a function of its own price. It is in fact set by the firm, and is an

increasing function of its product price:

$$q = f(P)$$

Therefore, all else being equal, an increase in the final product price (P) will shift the marginal revenue product function outward. This results in both a larger quantity purchased and a higher delivered wood price in equilibrium.

C. Potential Implications For Alberta

How or in what way can this theoretical model be expected to hold in Alberta? First of all it must be remembered that large spatially monopsonistic firms in Alberta that have purchased wood from surrounding land owners still obtain most of their wood supply from the province.[5] The authority to set stumpage rates is given in provincial legislation.[6] This legislation also allows the province to negotiate stumpage rates with firms. The stumpage price set by the province for green coniferous timber suitable for lumber manufacture is $0.70 per cubic

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[5]One firm in central Alberta obtains about 14.6% of their annual wood supply from landowners, Winship, R. pers. comm. 1989.

[6]This information was obtained from the Forests Act, Timber Management Regulation 60/73 up to and including amendments 297/87, and the Forest Management Agreement (O. C. 778/88) with Procter and Gamble Inc.

metre. Other dues vary between $0.15 per cubic metre to $0.85 per cubic metre depending on use, size, and species of the wood. In addition, for one forest firm with a forest management agreement, the charge for coniferous species is $2.09 per cubic metre and $0.27 per cubic metre for deciduous species. These charges are indexed to a quoted bleached kraft pulp price annually.[7] In addition to these charges, forest firms must pay an area-based charge for the publicly provided service of protection from fire on the tenured lands. For the same forest firm mentioned previously, these area-based charges are $3.64 per square kilometre per year,and $20.02 per square kilometre per year, and they are adjusted for inflation annually. As well, for firms that do not themselves assume the cost of reforestation, a charge of $2.30 per cubic metre of wood harvested is levied in lieu of restocking these areas. There is no indication or available literature to indicate how or if these negotiated charges reflect the true scarcity rents that could be obtained from the use of public timber. Since most of these rates are determined with almost no regard for changes in final product prices, there should be no incentive for Alberta firms to pay any higher roundwood prices to land owners than they do for

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[7]Most pulpwood stumpage rates negotiated in Forest Management Agreements are adjusted annually to an estimated market pulp price index, and all other rates are fixed.

roundwood prices from the province.[8] This is certainly not refuted by the data collected on conversion returns to private land owners. Although there is considerable variability in these imputed stumpage values collected in the survey, the average seems to be roughly equivalent to the amount paid in provincial charges for the rights to wood from public land.

The assumption of the relative costs of harvesting on private versus public land would not be complete without addressing one more important issue. The apparent disincentive for forestry firms to pay any higher roundwood price can further be impaired by transactions costs. These transactions costs would arise for two major reasons:

1. There may be a cost to the firm involved in procuring wood from many small land owners versus the relative cost of obtaining wood from one large owner, namely the Government. It would be extremely difficult to determine the relative importance of these costs to the firm, but it is essential to include this as an important factor in the market structure.

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[8]Most pulpwood stumpage rates negotiated in Forest Management Agreements are adjusted annually to an estimated market pulp price index, and all other rates are fixed.

2. A wood supply to a large forest firm from public land is either a quota or a forest management agreement. This provides the firm with a secure long term source of wood. This is not the case for wood from private land, which is perhaps best characterized as unstable in terms of quantity and quality of supply, relative to publicly owned supplies. This uncertainty of wood supply from private land versus public for a forestry firm is therefore characterized as a transaction cost to the firm.

The ideas of relative bargaining strengths for buyers and sellers, and the presence of these transactions costs, are to some degree embodied in the fact that there is value inherent in information regarding both delivered wood costs and prices, and final product prices. For forestry firms there is considerable incentive in aquiring accurate information in these areas, however individual land owners must often obtain this information at a cost to themselves. This combined with the relative investments by firms and land owners in factors involved in the production of delivered wood may make these costs to land owners prohibitive.

Boyd and Hyde, (1989) discuss the availability of a stumpage price reporting service called Timber Mart South (TMS). TMS publishes monthly average prices for sales of stumpage in thirty-eight substate regions in the southeastern U.S.. From 1977 to 1980 it was funded by the U.S. Department of Agriculture, but is now entirely private

and self-supporting, and is a typical example of forestry assistance that acknowledges the presence of higher transactions cost for land owners. Boyd and Hyde suggest that knowledge of stumpage prices should ultimately reduce the uncertainty of timber sales by land owners, and improve their competitive positions relative to forest firms.

Now that the stage has been set with a discussion of the effects of market failure on stumpage prices,we can begin to analyze the data collected. This analysis will help to determine the critical market and land owner characteristics that will affect their willingness to be future suppliers of roundwood.

CHAPTER III

MICROECONOMICS OF PRIVATE TIMBER SUPPLY: QUESTIONAIRE RESULTS

A. The Survey

Information on the timber harvesting profile of private land owners does not exist for Alberta. It is very difficult to even begin to identify land owners who may have sufficient merchantable fibre to even consider the possibility of harvesting.

Due to the problem of defining the population of private forest land owners, it was decided to focus on the population of land owners that are known to have supplied fibre to two firms in West central Alberta; one in Drayton Valley and one in Edson. These firms owned by the same company purchase both aspen and softwoods in producing oriented strand board, and some dimension softwood lumber. A list of fifty land owners that have supplied wood to these firms was obtained from the company. As well a shorter list of 17 potential respondents was obtained from District Agriculturalists of the Provincial Department of Agriculture in order to obtain information on land owners in the area with forest land that have never harvested fibre. Of these seventeen respondents, seven were interviewed and of the other fifty respondents, 31 were interviewed, for a total sample size of thirty eight. A copy of the survey is included in the appendix.

Two recent surveys of western Canadian land owners were used in formulating questions for the survey.[1] Both of these were extensive mail-out questionaires, and did not focus on obtaining details of harvesting histories, or physical characteristics of the forest lands in question.

The ability to conduct personal interviews allows for more flexibility in collecting detailed information. This combined with the fact that harvesting wood from private land is not an extensive activity in Alberta, were the primary reasons a smaller number of personal interviews was chosen over a larger mail-out survey, such as those previously mentioned.

Since it is not known exactly how many forest land owners are within the geographic wood supply area sampled, it is not possible to determine the extent of bias in the sample. Even if it were possible to determine how many land owners in a geographic wood supply area had the potential to supply wood, it would require a large number of restrictive assumptions to directly extrapolate the results from only seven respondents over an entire population. However, given that the primary reason for any land ownership in the area is for agricultural purposes, it can be safely concluded that the number of land owners that

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[1]See James, 1988. A Survey of Bush Ownership in Alberta, and Wetton, C. E. 1988, A Survey of Private Forestland Owners in B.C.

could potentially supply fibre, but have not, is large. Since this latter group of land owners constitutes only seven out of thirty-eight in the sample, one can conclude that they are underrepresented in our sample, but to what extent is not known.

This bias has resulted in what is known as a censored sample.[2] In other words, the land owners that own forest in the geographical area, and have not sold timber, are not sufficiently represented in the total sample size of 38. When the survey was initiated, it was decided to obtain as much information as possible from land owners that had sold timber. In so doing, it is believed that the benefits of obtaining more detail on a smaller, select group within the sample are greater than the disadvantages of having a biased sample.

In order to begin to obtain the detailed data, respondents were initially contacted by telephone to describe the purpose of the survey and to arrange an appointment. All interviews were conducted during May of 1989, generally at the respondents' residences. Each interview took approximately one hour, but due to what seems to be a considerable lack of information about forestry practices and policies in Alberta, some interviews were quite lengthy with more questions being asked by the

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[2]See Judge et al., 1985 for a complete description of censored samples.

respondents than by the interviewer.

B.The Sample Area Characteristics

The 38 survey respondents were located in the following Counties and improvement districts in west-central Alberta:

1. Improvement Districts 14 (58%) and 10 (10.5%).
2. Counties 25 (18.4%), 31 (2.6%), 77 (7.9%), 99 (2.6%).

The above percentages indicate the number of respondents in each respective county/improvement district. A map of their locations within Alberta follows in Figure 3.2 on page 29.

Since improvement district 14 has the greatest percentage of respondents, the following census data from Statistics Canada (1988) is presented in table 3.1 on the next page to describe the general nature of the sample area, and compare mean values with the this study's results.

The value of forest products sold in improvement district 14 in 1986 was $346,209 from 53 respondents. This compares to the whole province for 1986 with a value of $2,081,363 from 359 respondents.

These data show the large proportion of private land in the sample area being used for pasture, and grazing, with a relatively low amount of area under cultivation.

Table 3.1

Characteristics of Improvement District Fourteen

Compared to Survey Sample Means in hectares

	hectares	I.D.14	Survey
	total	means	
Total Area publicly Owned	2,264,775		
Total Farm Area Owned	121,593	147.6	187.1
Total Area Leased/Rented	74,556	210.5	-
Total Woodland Area	10,207	55.8	91.6
Unimproved Pasture	68,032	166.3	22.6
Other Unimproved Land	24,982	60.8	-
Crop land	56,285	74.1	62.3
Improved Pasture	27,729	57.1	7.3
Other Improved Land	2,761	5.7	-
Total Land Area	2,650,920		

Figure 3.1

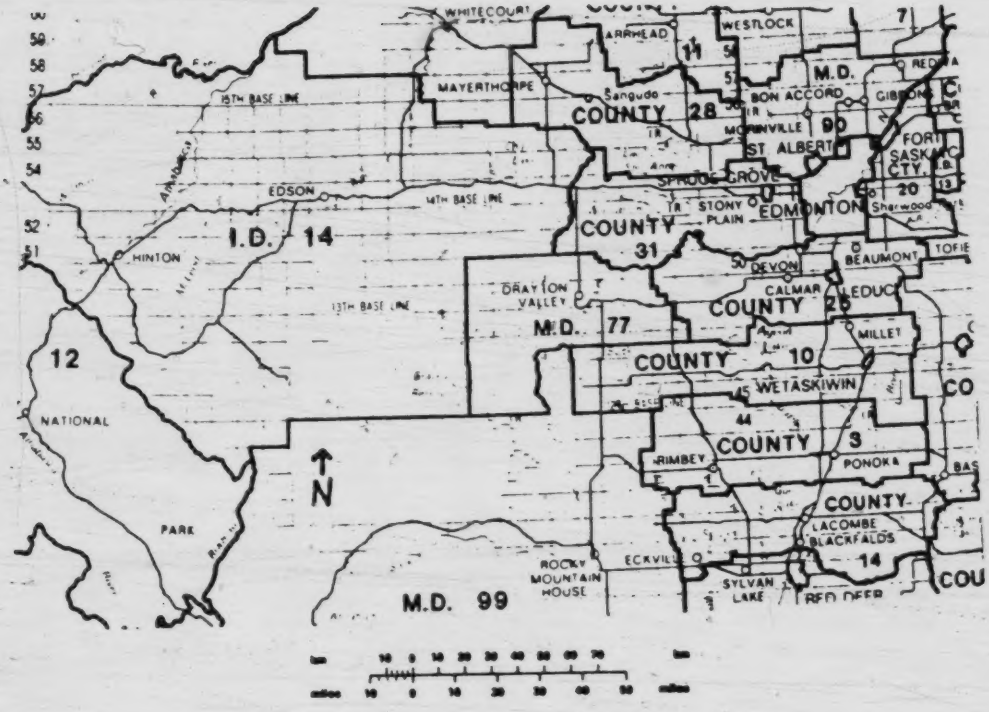

Figure 3.1 Map of Study Area

From Survey and Mapping Branch, Government of Alberta

Although this data is only for improvement district 14, it is generally typical of the other areas in which respondents were located.

C. The Questionaire Data

The overall response to the questions in the survey was extremely good, however there were two frequent problems noticed in answering the questions.

1.Most respondents keep no formal records of their harvesting activities, and relied strictly on memory to recall exact amounts, quantities, and times.

2. Most people had never thoroughly investigated the economic tradeoffs involved in harvesting, at least not in an explicit sense. For many people harvesting wood from their property was an experiment, with little *a priori* information to guide them.

In table 3.3 the means, standard errors, and percent responses are presented for the answers to the questions on physical land characteristics. They can be generally characterized by considerable variations in the sizes of land ownerships, and the productivity of land owned.

Most land owners had some combination of forest, cultivated, and pasture lands, and fewer land owners had leased or rented forest land or improved pasture. Respondents have owned their land for an average of almost eighteen years, but this is subject to a wide degree of variation.

TABLE 3.2

Means, Standard Errors, and Percent Responses of Physical Land Ownership Characteristics in hectares

	Mean	Standard Dev.	% Response
Total Land Owned	187.1	155.1	100
Total Forest Land	91.58	82.55	100
Total Forest Leased/Rented	45.6	150.4	26
Area Cultivated	62.28	80.88	76
Area Unimproved Pasture	22.59	40.17	50
Area Improved Pasture	7.34	17.65	26

Thirty-five of 38 respondents originally purchased their land, while the remaining three inherited it.

Fifty-eight percent of land owners graze cattle on their land on a regular basis, while seventy-six percent, regulary own some livestock.

Seventeen out of 38 land owners gave their main occupation as farmer or rancher, however, all land owners obtained at least some income from their land , whether it was from crops, livestock, rental/lease payments, royalties from oil and gas activites, or stumpage payments.

Five of 38 respondents listed their primary occupation in forestry or logging operations, and the rest comprised a variety of occupations, with some bias toward employment in oil and gas related industries.

Only three of 38 respondents did not reside on their

land, and only one of these three resides in a city of over five hundred thousand people.

Twenty five of 38 respondents' households were classified as a couple with children , and eleven of thirty-eight were classified as a couple without children.

In table 3.4 on the next page the means, standard errors, and response rates are presented for a number of socio-economic characterisitcs. As with the land characteristics, these variables show a considerable degree of variation. The data in table 3.4 are taken from answers to questions 13 to 23 of the survey (see Appendix). Respondents were asked about the alternate use values of forest land, after they had harvested it. Out of 27 respondents that harvested, 12 will convert their harvested land to pasture for grazing, six will convert it to crop land, four will let it grow back to forest, three will allow trees to grow back and graze it as well, and two had other uses for the land.

Question 17 asks what minimum price of timber would persuade the respondent to continue to use their forest land for producing fibre after it was harvested. Only three of 27 were able to answer the question. However when respondents were asked (question 18) if they would prefer to keep their forest land in forest production after it had been harvested if the returns for doing so were equivalent to the next best alternate use, 28 out of 38 respondents answered yes.

TABLE 3.3

Means, Standard Deviations, and Response Rates for a Number of Socio-Economic Characteristics

	Mean	Standard Dev.	% Response
Years Owned Forest	17.9	11.43	100.0
Years Leased/Rented Forest	10.9	6.33	31.6
Years Forest in Family	23.1	15.55	100.0
Rent from Grazing After Harvest $/ha./year	12.9	9.43	65.7
Crop Rent From Area Harvested $/ha./year	32.7	11.23	26.3
Minimum Price to Keep Forest in Production $/m3 of wood	26.3	10.11	7.9
Household Income $	38150.0	23600.0	100.0
Average Education Level	grade 12	alot of variation	100.0
Percent of Income From Harvest Average Over Last Five Years	1.09	9.54	100.0

There is an apparent disparity between the responses to these questions, where a majority approved of keeping land in forest production for returns equivalent to the next best alternate use of the land, and only a minority being able to identify the approximate price of wood they would be willing to accept to keep the land as forest. This result would indicate that land owners have insufficient information and experience in dealing with the market values of their forest land for timber production. Land owners that have harvested and will continue to harvest on an annual basis did seem to have greater experience and information in markets for wood products, as both were affiliated with or owned small portable sawmills.

From table 3.4 it can be seen that considerable variation exists in the alternate land rents for cleared or harvested forest land. This has to do with variations in land productivity, the condition the land is left in after being cleared or harvested, the availability of water if the land is used for grazing, accessibility, and other unique characteristics of the land.[3] For these reasons, it is difficult to generalize on the "best" or highest present

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[3]Returns to land from property access rights from oil and gas activity which is common in certain areas of the study region were not included. These revenues, where they occur, can significantly alter the opportunity costs for a variety of land uses.

value use of forest land.

In table 3.4 the means, standard errors, and response rates for the questions on harvesting activity are presented. All dollar values were adjusted to 1989 dollars using the gross domestic product implicit price index from the Alberta Bureau of Statistics. The cost of production data show less variation than do the conversion return values.

TABLE 3.4
Means, Standard Errors, and Response Rates For Land Owner's Harvest Histories

	Mean	Std. Error	% Response
Area Cleared ha.	21.56	29.01	42.1
Deciduous Volume m3	380.00	451.30	63.1
Coniferous Volume m3	133.30	399.70	66.6
Conversion Return $/m3**	2.83	4.29	63.1
Harvest Cost $/m3	7.42	3.04	55.3
Transport to Mill Cost $/m3	7.54	3.37	50.0
Delivered Wood Price $/m3	17.49	4.39	55.3

**all prices and costs in table 3.4 are in 1989 dollars

Stumpage, or conversion return is calculated as:[4]

delivered wood price at the mill gate - cost of harvesting - the cost of loading and transportation =

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[4]This formula could only be used if the respondent provided all three numbers. If not all the data was provided, conversion return was either not calculated, or was estimated by the respondent.

conversion return or stumpage price.

In this fashion the correct definition of stumpage price is used, as the residual value that accrues to the timber itself (Gregory, 1972). However, it is not known how these conversion returns relate to the definition of scarcity rent. In order to determine the amount of scarcity rent that accrues to the value of wood, one must determine the difference between final product price, and marginal production costs, over different levels of output (Anderson, 1985). Since this information is not included in this study, it is not possible to determine the optimal amount of rent that land owners could collect from their harvesting activities.

Actual conversion return values varied considerably with different harvests. Since costs, and delivered wood prices have low variabilities both across respondents and over time, this variance must be a direct result of the actual volumes harvested per unit area. These results support a conclusion that it is the actual volume, density, and soundness of the wood that will have the greatest influence on the conversion return. From a wood supply point of view, this is consistent with results from Carlen and Muller (1985), where it was found that actual stand characteristics were very important in the land owner's decision to harvest. Since most land owners interviewed, had no formal inventory for any of their forest land base, the decisions they make on whether or not to harvest may

not be based on meaningful estimates of conversion returns. In order for a land owner to complete a useful inventory of merchantable volume and productivity on his forest land base would involve an obvious transaction cost. This cost to the land owner may even be prohibitive, depending on the size and quality of the forest land.

D. Results From The Open-Ended Questions

In additon to these quantitative results that have just been described, several open-ended, or opinion questions were asked of respondents. There were many very colourful answers, that unfortunately were coded as either positive/negative or yes/no using ones and zeroes. Question number 24 was met by mostly puzzling looks from the majority of respondents. It asks "If forestry investments are not profitable to you, would you be more likely to consider pursuing forestry activities if there were government assistance programs available?" Respondents understood the question, however, most were not aware that any forestry assistance programs exist anywhere in Canada, or otherwise, and could not imagine how they would be implemented to benefit forest land owners. Eighteen out of 38 respondents answered yes or positive to the question. Regardless of whether they answered yes or no, the answers were guarded, due to the apparent unfamiliarity with private forest land assistance programs. Several

respondents noted that there are presently two major disincentives to supplying wood from their land. The first is the ability of land owners to receive tax concessions for managing a property for agricultural income. A property that is not fenced, or cleared of some brush/forest can be assessed as much as three times more in annual property taxes. One respondent noted that he would pay $600 in annual property taxes for 64 ha of unfenced forest land versus $200 annually for 64 ha of fenced and partially cleared land used for grazing purposes. The other perceived disincentive is the payment of Alberta Worker's compensation premiums. Several respondents noted that in order to be able to sell their wood to a mill, they were required to pay premiums of approximately $1000 annually. They felt this was an exhorbitant transaction cost, as they were not required to pay these premiums to sell agricultural commodities from their land.

Question number 25 asks "What problems do you anticipate in growing, harvesting, and selling wood?" Twenty-three out of 38 respondents were able to identify one or more problems. A common response was that delivered wood prices were far too low to even consider significant re-investments in their wood supplies. One respondent said that he had received better prices for coniferous logs transporting them to a British Columbia interior sawmill than transporting them approximately 40 miles from where they were harvested to a sawmill in Alberta.

Many respondents also stated that present revenues from harvesting would not even cover the costs of clearing land for agricultural purposes after it had been harvested. They noted that it cost considerably less to clear land with standing timber on it as it is easier to uproot whole trees than stumps.

Several respondents felt that the economic benefits to them of maintaining their forests were greater if they were left standing. These respondents noted benefits from protection from wind and water erosion, shelter for livestock, and habitat for wildlife. Only one respondent harvested specifically for the purposes of enhancing wildlife habitat, and he also had the lowest conversion return of all respondents.

Question 26 asks,"What role do you forsee for government in helping you with these problems?" Only 15 of 38 respondents were able to identify some role for government intervention. As with question 24, many respondents found the question difficult to answer, as most had no *a priori* information or expectations of how or if governments have any role to play in private forest land management. A few respondents had strong opinions both for and against government involvement, but most responses were guarded. Of the few positive responses to this question, respondents felt that government should charge forestry firms more for wood, so that firms would have a greater incentive to pay more for the wood from private land.

Question 27 asks, "What percentage of your total forest land will always remain in an untouched state?" The answer to this question is believed to be a significant variable in determining the willingness of land owners to supply wood in the future. By indicating the percent of their total forest land that will never be harvested, they are also indicating how much forest land they intend to use as a wood supply. The second part of the question asks, the annual value of this "untouchable" forest land in dollars per ha per year. Most individuals found this question difficult to answer. A number of respondents said that their reserved forest land was "priceless" or, "worth more than the value of money". In this sense, respondents appeared to interpret the question as either a type of "willingness to pay" for forest land, or a "willingness to accept compensation" for the loss of their forest land, that they have chosen not to use for harvesting. It is also an indication of respondents' abilities to place value on forest land for its non-market and aesthetic qualities. However, a number of respondents answered the question by providing a value consistent with what they thought they could get from either selling or renting the land. Therefore, the only conclusion one can draw, is that there is considerable variability among a small sample of land owners in placing values on a variety of characteristics of their forest lands.

Question 27c. attempted to set up a type of bidding

game to ask land owners how much of their total forest land they would supply for harvesting on an annual basis if they were guaranteed increasing amounts of income per ha per year from harvesting in perpetuity. Eight different income levels from zero $ to $125 per ha per year were presented. Response to the question was one hundred percent. At a level of $5 per ha. per year, only three of 38 respondents were willing to supply any land for harvesting. At $125 per ha. per year, 24 of 38 respondents would supply land for harvesting. The respondents were told that these were annual revenues in perpetuity, consistent with a sustainable level of harvest, over whatever amount of land base they chose to make available for harvesting. Figures 3.3 and 3.4 describe these results.

Figure 3.3 Number of Respondents Committing Forest to Production at Different Levels of Return

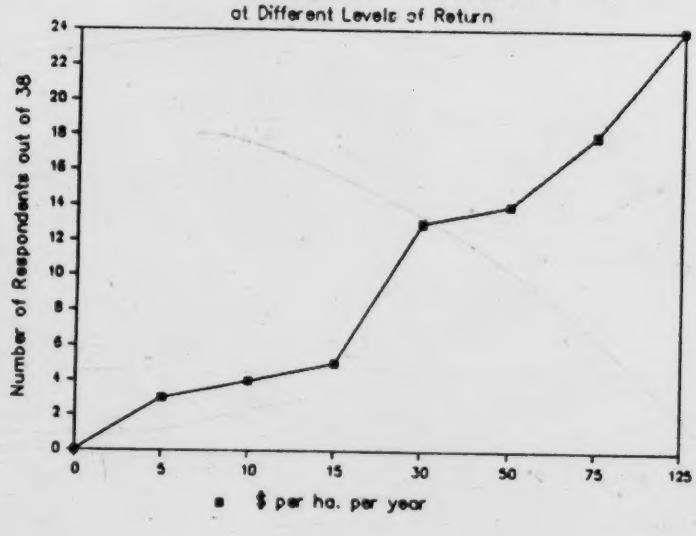
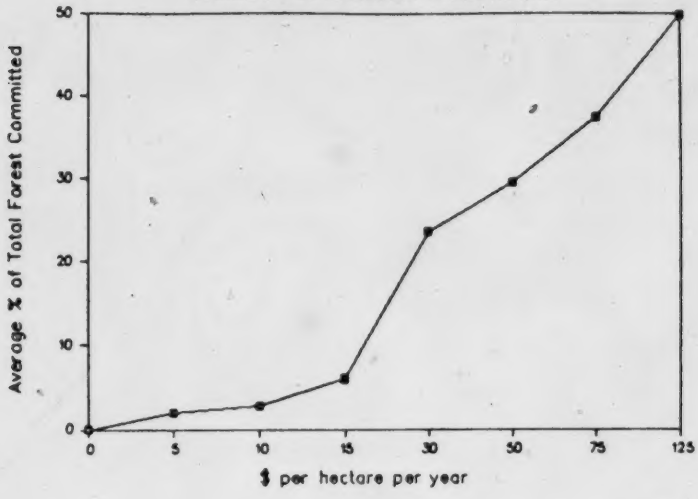


Figure 3.4 Average Percent of Total Forest Committed to Production at Set Returns



Most respondents did not initially understand the question. It had to be explained to them in detail, and even then, most respondents found it difficult to decide on an appropriate $ per ha per year figure that they considered either poor or substantial returns from harvesting their land. It is also important to note from this question that even with a return of $125 per ha. per year, 14 of 38 respondents stated they would not make any amount of their land available for harvesting on an annual basis. This implies that for these respondents, alternative use or contingent values of their forest land that would exclude harvesting, are greater than $125 per ha per year.

CHAPTER IV

THE DETERMINANTS OF PRIVATE TIMBER SUPPLY: METHODOLOGY

A. Application of a Binary Choice Model

Now that a full description of the survey results has been given, the task of using the data to analyze land owner's supply and demand decisions can begin.

The use of a binary choice model to determine factors that will affect a land owner's decision to harvest fibre from the private land is consistent with the view that forest land owners strive to maximize utility. The utility inherent in a particular decision for a land owner is based on the attributes of the choice specific to the individual, other socioeconomic characteristics, and a random disturbance (Judge et al., 1985, pp.753-785). This situation can be described as follows:[1]

Let: U_{io} and U_{i1} denote the utilities of choices, z'_{io} and z'_{i1} denote the vectors of characterisitcs of the choices, w_i a vector of the socio-economic characteristics of the individual:

And then:

$$U_{io} = U_{io} + e_o = \alpha_o + z'_{io}\delta + w_i\gamma_o + e_{io}$$

$$U_{i1} = U_{i1} + e_1 = \alpha_1 + z'_{i1}\delta + w_i\gamma_1 + e_{i1}$$

δ and γ are coefficients, and e is an error term normally

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[1]Adapted from Judge et al., 1985

distributed with $\mu=0$ and variance of one. The α's are constants.

Thus $Y_i = 1$ if $U_{i1} > U_{io}$ and $Y_i = 0$ if $U_{io} > U_{i1}$

and Probability$(Y_i = 1) = P(U_{i1} > U_{io})$

$= P[(e_{io} - e_{i1}) < (\alpha_1 - \alpha_o) + z_{i1} - z_{io})' \delta + w'(\gamma_i - \gamma_o)]$

$= F(X'_i B)$

where: $X'_i = (1, z_{i1} - z_{io})', w'_i)$,

$B' = ((\alpha_1 - \alpha_o)\delta'(\gamma_1 - \gamma_o)')$, and F is the cumulative distribution function of $(e_{io} - e_{i1})$.

The presence of an intercept implies that the choices have effects on utility apart from their attributes. For example, the decision not to harvest timber may be affected by non-market values inherent in the ownership of forest land. This point will be further elaborated upon in the following results chapter.

Choice models are defined in terms of the functional form of F. For a logit model F is described as follows:

$$F(X'_i B) = 1/(1 + e^{X'_i B})$$

There have been many applications of binary choice models to assess the behavior of forest land owners.[2] Some of these have used only cross sectional data, while Binkley (1981) has used both cross sectional and time series. Due to the intertemporal nature of harvesting, time series data on harvesting and other land uses combined with economic

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[2]Carlen and Muller, 1985; Jamnick and Beckett, 1988; Greene and Blatner, 1986; Romm et al., 1987; Binkely, 1981;

data are the most ideal in analyzing the wood supply question. Binkely (1981) notes that the decision to harvest in a given year will obviously be linked to how much has been harvested in the past, as well as expectations for the future. In order to incorporate this notion in this study's cross sectional analysis, respondents were asked a variety of questions about their harvesting histories, and if future plans to supply wood include harvesting timber from their land.

The logit model as described is used to estimate the following relationship for land owners that have harvested within the last five years:

Probability of future harvest for those who have already harvested = F(amount of merchantable growing stock, percent of income derived from harvesting, stumpage price received, would prefer forest versus other land uses if the returns to both were the same, household income, presence of a harvest plan) + random error term.

This model will be estimated using a maximum likelihood procedure written with Gauss (version 1.49b) software. The maximum likelihood procedure provides estimates that are consistent, asymptotically efficient, and asymptotically normally distributed. The method employed in Gauss for maximizing the likelihood function is an iterative procedure called the Newton-Raphson method. This method allows for the convergence to the global

maximum based on any set of starting values for the coefficients given the properties of the log likelihood function for the logistic cumulative distribution function (Judge et al., 1982, pp.523).

B. Application of a Model With a Continuous Dependent Variable

In order to estimate a similar equation that attempts to explain all land owners' propensities to supply timber regardless of whether or not they have ever harvested, the sample bias problem must be dealt with.

A commonly used procedure developed by Heckman (1976, pp.475-492) treates the censored sample problem with the inclusion of an additional explanatory variable. The procedure can be described as follows:[3]

Given that $h(U_{0i},U_{1i})$, is the joint density of U_{0i} and U_{1i} and it is bivariate normal then:

$$E(U_{0i}|Y_{1i}>0) = E(U_{0i}|U_{1i}>-X_{1i}B_1) = (\sigma_{01}/(\sigma_{11})^{1/2}) * \lambda_i$$

$$E(U_{1i}|Y_{1i}>0) = E(U_{1i}|U_{1i}>-X_{1i}B_1) = (\sigma_{01}/(\sigma_{11})^{1/2}) * \lambda_i$$

where:

$$\lambda_i = f(\phi_i)/1-F(\phi_i) \qquad \text{and} \quad \phi_i = -X_{1i}B_1/(\sigma_{11})^{1/2}$$

U_{0i} = Utility inherent in not supplying wood for each land owner i.

U_{1i} = Utility inherent in supplying wood for each land

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[3]Adapted from Judge et al.,1985, and Heckman, 1976.

owner i.

$E(U_{0i} | Y_{1i} > 0)$ = the expected value of the utility inherent in not supplying wood for each land owner i, given that the probability of supplying wood exists.

$E(U_{1i} | Y_{1i} > 0)$ = the expected value of the utility inherent in supplying wood for each land owner i, given that the probability of supplying wood exists,

and f and F are respectively the density and distribution functions of the standard normal distribution.

"λ_i" is the inverse of Mill's ratio and has the following properties:

1. Its denominator is the probability that a land owner has supplied wood.

2. The lower the probability that a land owner has supplied wood, the greater the value of λ for that observation.

Given these two properties, one can see that the inverse of Mill's ratio (IMR) acts to give a greater weighting to land owners that have not (or have a low probability) supplied wood. When added to the OLS equation to estimate the amount of land an owner will reserve for harvesting, the IMR adjusts for the low number of respondents who may, but have not previously supplied wood.

The final model with the inclusion of the IMR is as follows:

$$E(Y_{0i}|X_{0i}, Y_{1i} \geq 0) = X_{0i}B_0 + (\sigma_{01}/(\sigma_{11})^{1/2}) * \lambda_i$$
$$E(Y_{1i}|X_{1i}, Y_{1i} \geq 0) = X_{1i}B_1 + (\sigma_{11}/(\sigma_{11})^{1/2}) * \lambda_i$$

Heckman's (1976) procedure as applied to this study can be described in the following steps:

1. Estimate a probit model based on the following equation:

probability that a given forest land owner answered "yes" to the question on the importance of long term harvests = F(percent of total land area owned that is merchantable forest, household income).

2. From the results of the probit model, calculate the instrumental variable, called the inverse of Mill's ratio (IMR):

IMR = probability density function (v)/cumulative distribution function(v).

where v = the estimated probit equation described above.

3. The vector that is the IMR is included as an additional explanatory variable in an OLS equation where:

percent of forest land never to be harvested = F(importance of long term harvesting, household income, IMR).

Since the Heckman procedure specifies that the final output is the estimation of an Ordinary Least Squares equation (OLS), it is necessary to have a continuous variable as the dependent variable. This is why the answer to question 27a, the percent of forest land never to be harvested is used as a proxy for the willingness of

land owners to supply wood.[4]

Using this procedure is likely to result in some heteroskedasticity with the error terms in the OLS equations (Judge et al., 1985). It has been recommended by Heckman (1976) and Judge et al., (1985) that instead of using OLS to estimate the equation, a generalized least squares estimator would improve the precision of the equation. The presence of heteroskedastic error terms is tested for and explained in the results chapter. The other major statistical problem of dependence among independent variables will also be discussed, as it affects the model estimation procedures and results.

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[4]The author recognizes that forest land area owned by an individual is not perfectly continuous, i.e. one cannot own an infinite or negative amount of land.

CHAPTER V

THE DETERMINANTS OF PRIVATE TIMBER SUPPLY: MODEL RESULTS

A. The Logit Model Results

The data used to estimate a logit model is that for respondents who answered yes to the question, "Have you ever harvested wood products from your land?" Twenty-four of 28 respondents answering yes to this question were able to provide data for the variables used in the logit model. These 24 responses to a yes-no question become the dependent variable for the logit model. There were eight "yes" responses and 16 "no" responses.

Based on the results of other studies, it was decided that the following kinds of variables would be useful in predicting the likelihood that a land owner will supply wood in the future (Binkely, 1981, Carlen and Muller, 1985, Jamnick and Clements, 1987).

1. The dependent variable (SUPPLY), (answer to question 20a.) provides an indication of a land owner's likelihood of supplying wood in the future.

2. The first independent variable (MERCHGS), is the number of ha of potentially merchantable growing stock. This variable should be positively related to wood supply. It includes only those forest land areas covered by merchantable species such as pine, white spruce, and aspen.

3. The second independent variable (INC%), the percent

of income from harvest on average over the last five years was expected to be positively related to future wood supply.

4. The third independent variable (STUMP), conversion return was also expected to be positively related to future wood supply.

5. The fourth independent variable (PREFER), a dummy variable is related to respondent's preferences for the use of their forest land. It was believed that respondents that preferred to use their land for growing trees if the returns from doing so were at least as great as the returns from alternate uses of their forest land would be more inclined to be future suppliers of wood.

6. The fifth independent variable (INCOME) household income was expected to be negatively related to future wood supply.

7. The sixth independent variable (MANAG), presence of a management plan for harvesting, was thought to be positively related to future wood supply.

In order to decide which of the six independent variables were the most significant in predicting propensity to supply wood in the future, each variable was run individually in the model. Table 5.1 shows the results from each of the six models.

The number of observations for each model is 24 and the degrees of freedom is 22. The P-value indicates the probability that the coefficient is not different from

zero. A low P-value indicates a coefficient is more likley to be significantly different from zero.

The presence of a constant (the intercept) implies that the choices have effects on utility apart from their attributes (Judge et al., 1985, pp. 756). This means that the value of the intercept could include the associated non-fibre and amenity values, and other aspects of the decision to harvest, that are not included as independent variables in this model.

Independent variables MERCHGS, PREFER, INCOME, and MANAG show only very small degrees of significance. The coeffient for the area of potentially merchantable timber is positive, which is expected, however due to the variation in ha. of land owned, there appears to be little substantial relationship between propensity to supply wood and the amount of land owned. This, however may be important to know when instituting any policy toward forest land owners, because it implies that even ownerships of relatively small areas of forest land may in aggregate be very important sources of supply, and conversely, larger ownerships of forest land may not be more important sources.

TABLE 5.1

Results from Logit Analysis of Harvesters

	Mean	Standard Error	Minimum	Maximum
SUPPLY	0.291667	0.548315	0.0000	1.0000
MERCHGS	75.275000	103.766446	0.0000	243.0000
INC%	8.845833	13.982600	0.0000	40.0000
STUMP	4.392083	8.197828	-13.0000	24.3900
PREFER	0.791667	0.893777	0.0000	1.0000
INCOME	38.958333	46.277635	5.0000	80.0000
MANAG	2.541667	2.625460	1.0000	3.0000

	Variable	Coefficient	Std. Error	t-stat.	P-value
model1:	constant	-1.2223	0.6862	-1.7814	0.0886
	MERCHGS	0.0042	0.0062	0.6801	0.5035
model2:	constant	-2.6338	0.9497	-2.7733	0.0112
	INC%	0.1658	0.0671	2.4718	0.0216
model3:	constant	-2.2064	0.8516	-2.5909	0.0166
	STUMP	0.2532	0.1298	1.9503	0.0639
model4:	constant	-1.3863	1.1180	-1.2399	0.2281
	PREFER	0.6131	1.2221	0.5017	0.6209
model5:	constant	-0.3178	0.8312	-0.3824	0.7058
	INCOME	-0.0154	0.0199	-0.7743	0.4469
model6:	constant	41.3974	4869.2575	0.0085	0.9933
	MANAG	-20.2405	2434.6286	-0.0083	0.9934

The second model (in table 5.1) with the average percent of annual income (INC%) from harvesting over the last five years as an independent variable, is quite significant in predicting propensity to supply wood. As the percent of total income from harvesting in the previous five years increases, so does the likelihood of the respondent being a future supplier of wood. This result emphasizes the economic importance of the decision to continue to supply wood, but it does not consider the marginal benefit(s) of choosing to supply wood. For this model a type of supply elasticity can be calculated. Given a one unit change in the percent of annual income derived from harvesting, there will be a 3% change in the probability that a land owner will supply wood in the future.

The third independent variable, the conversion return (STUMP) is also a significant predictor of the propensity to supply wood. If land owners' previous years harvesting have been successful in terms of the profits generated, then they should be more likely to consider supplying wood in the future. As with the previous INC% variable a type of supply elasticity can be calculated for STUMP. For a one unit change in the stumpage return received there will be a 4.7% increase in the probability that a land owner will supply wood in the future.

The variable STUMP may also act as a proxy for other important considerations in supplying wood, such as wood

quality, and the efficiency of the harvesting operations. If conversion returns are high, one would expect both the quality of the fibre, and/or the efficiency of harvesting to also be high. However, past success in harvesting as a predictor of future supply may be limited by other obvious considerations such as changes in relative prices of wood products, and agricultural products over time.

The fourth independent variable, (PREFER) preference for forest land uses over other land uses at the margin, is not very significant. Part of the problem with using one qualitative binary variable to predict another lies in the resulting limitations in actual numerical values used in the estimation process, especially when the degrees of freedom are limited. Another problem with this variable is that even though respondents' preferences for forest land uses may include harvesting, they may have greater preferences for a variety of specific uses of their forest. In this regard respondents may prefer to rely on income from some combination of grazing, crop production, and harvesting, in the use of their forest land as well as reserving parts of it for non-market benefits. This strategy for dealing with the uncertainty in relative price changes over time is consistent with risk averse behavior. Such decisions are analyzed in a model of choice by Mills and Hoover (1982). From this it follows that a strict preference for forest land is not a requisite for determining if a land owner will supply wood in the future.

The fifth independent variable, household income (INCOME) is negatively correlated to propensity to supply wood in the future, however it is not significant. The negative sign on the coefficient, which is consistent with the results of previous studies, indicates that land owners are less likely to harvest as their income increases. Johansson and Lofgren's (1985 pp.141) model of the self-employed forest farmer shows that as income (and time) from sources of employment other than harvesting increases, they will be less likely to supply wood. This is consistent with higher levels of income. This study does not rigorously analyze relative prices between harvesting, agricultural, and industrial sources of land owner's incomes which are the driving forces in Johansson and Lofgren's model. The results in this study are however consistent with the idea that as one's relative wealth increases, one would be less likely to rely on income from harvesting, and forego these opportunity costs in favour of owning forest land for its non-fibre benefits. James (1988) in his study of Alberta forest land owners notes that people recognize the non-fibre benefits of owning forest land.

The sixth variable, presence of a forest management plan had the least amount of explanatory power in predicting propensity to supply wood. It takes the form of a dummy variable; 1 = no management plan for harvesting, 2 = some consideration of deciding on when and where

clearcutting will occur, 3 = a clearcut or selection logging system with some plans for regeneration. This variable was insignificant primarily because many respondents were harvesting with the intent of ultimately clearing land for agricultural purposes.

Only a very few respondents were truly interested in managing their land for timber outputs. Therefore, even though land owners may consider supplying wood, most of them are treating their wood supply as a finite, exhaustible resource, and not a renewable one. Only one respondent from the entire survey chose to invest the time and effort involved in crushing and spreading logging slash over some harvested areas, to distribute pine cones for natural regeneration.

The results from the logit analysis indicate that even with a very small sample, some significant results can be obtained to determine the likelihood of land owners' willingness to continue to supply wood. The model shows that if past harvesting efforts have been successful, the land owner will be inclined to pursue supplying wood in the future. Other variables such as area of ownership, income, degree of forest management, may not be significant factors in the propensity to supply wood for these land owners, as they have been noted to be in other studies. Further sampling and testing of Alberta land owners to account for substantial variability in these data would be required to prove or disprove these hypotheses.

B. Probit Model and Heckman Procedure Results

For the probit model estimation, the full sample of thirty-eight respondents was used. As a result, variables that were thought to be useful in the model estimation do not refer to specific harvesting activities, since not all of the respondents have a history of harvesting. The probit model estimates the probability that a land owner had supplied wood in the past.

Attempts to use a number of these variables in the estimation of the probit model were generally unsuccessful, due to their low explanatory power. The following variables were not significant in estimating the probability of future wood supply:

1. The land owner's decision to supply wood in the future.

2. The household income of the land owner.

3. The land owner being or not being a farmer.

4. Whether or not the land owner has ever in the past cleared land with merchantable timber on it.

5.Whether or not the land owner thought there were significant market or institutional problems in selling wood.

6. Whether or not the land owner had some form of harvest managment plan.

7. Whether or not the land owner believed income from present sales of wood from his land were important.

The fact that the previous variables were insignificant may lead one to conclude that land owners are impossible to classify as potential future wood suppliers on the basis of these characteristics. However, as with the logit analysis, the low degree of explanatory power for most of the variables can be attributed to the wide variability in a small sample. These results will be important if and when more extensive information will be collected on the propensity of Alberta land owners to supply wood.

The only two variables found to have signifcant explanatory power in the probit estimation were the area of merchantable forest land, and the percent of total forest land available for future harvest. Of all the variables previously listed, these are perhaps the most significant because they are the most direct measures of quantitative land ownership characteristics. The results of the probit model are as follows in Table 5.2.

The output of the probit model provides an indication of the probability of a land owner being part of the subsample of wood suppliers. This is the basis for the weighting factor, the inverse of Mill's ratio, that gives a greater weight to those observations that are underrepresented in the sample, namely those respondents that have never supplied wood.

TABLE 5.2

Probit Model Estimation Results

Variable	Coefficient	Std. Error	t-stat	P-value
constant	1.0941	0.6471	1.6906	0.0998
merch. area	0.0081	0.0052	1.5395	0.1327
%land avail.	-1.3046	0.7675	-1.6998	0.0980

Observations = 38 Degrees of Freedom = 35

Percent Correctly Identified Respondents = 71%

An ordinary least squares equation was estimated, with the amount of forest land the respondent did not identify as "untouchable" as the dependent variable. The following variables were used:

1. The only continuous variable available that can act as a proxy for wood supply is the residual amount of forest land the respondent did not identify as "untouchable". This dependent variable is essentially the amount of forest land that would be potentially available for harvesting, at least for the existing growing stock, if not in perpetuity.

2. The first independent variable, (SUPPLYF) whether or not the respondent will supply wood in the future was significant on its own, but had little explanatory power, and was colinear with most of the other independent variables used.

3. The third independent variable, (INCOME) household income, was not significant due to the relative size of the coefficient. To get rid of this scale effect, household income was divided by 100. This did not have any

appreciable effect in causing it to become more significant. As well, the condition index is just below the critical value suggested by Belsley et al., (1980) for the presence of significant colinearity.[1] The critical value for the condition index suggested by Belsley et. al. is 30, and the value calculated was 28.4. Income is colinear with percent merchantable forest (MERCH).

4. The fourth independent variable, (MERCH) the percentage of total merchantable forest area was found to be significant. Since this variable was used in the probit analysis, it was believed that it could be highly colinear with the Inverse of Mill's ratio (IMR). The variance decomposition and condition indexes show this not to be the case, however, and therefore we can safely conclude that merchantable area and the IMR are independent.

The fifth independent variable (MARKET), was found to be colinear with (MERCH), the percent merchantable area,and more importantly, was not significant enough to really improve the equation. Table 5.3 presents the results from the final OLS equation. Further results from the OLS procedures showing the relationships among all variables tested appear in the appendix.

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[1]See Belsley, Kuh, and Welsch, 1980, ch.3 for a complete description of the definition and use of variance decomposition, and condition indexes to detect the presence of colinearity.

TABLE 5.3
Results from the OLS Estimation Procedure

Variable	Coefficient	Std. Error	t-Stat	P-value
Constant	146.6581	8.2014	17.8820	0.0000
MERCH	-5.7775	0.6276	-9.2061	0.0000
IMR	-157.8943	9.6645	-16.3376	0.0000

Condition Indexes		Variance Proportions	
		MERCH	IMR
1.0000	MERCH	0.0000	0.7767
15.4844	IMR	1.0000	0.2233

Overall these results compare favourably to the logit model results. The significance of the IMR illustrates the importance of accounting for the bias in the equation, and improves the overall estimation procedure. Income was once again not a significant variable. The percent of merchantable forest area, was not significant in the logit model results. Its significance for the sample of the entire population is perhaps a more important consideration. However, the fact that it is negatively related to land area potentially available as a wood supply, is not consistent with *a priori* expectations.The following explanations may shed some light on this apparent inconsistency:

1. Respondents that had never considered harvesting before, may not have done so because their forest is not considered to be of any value for fibre. Again, this result is consistent with Carlen and Muller (1985) who stress the

importance of land versus owner characteristics in predicting wood supply.

2. It may also be a reflection of the idea that forest owners who have invested in large areas of forest land may have done so not for its value to produce fibre. This hypothesis is supported by the results which show a bias toward eventual clearing of forest land for agricultural uses.

3. This negative relationship also enforces the idea that it is not necessary for a land owner to have a relatively large area of forest land to be interested in supplying wood. This is also prevalent in the logit results from harvesters only.

Heckman (1976) notes that a particular problem that may occur with the two step procedure is the resultant presence of heteroscedasticity. This is defined as increasing error variance with increasing values of the independent variable, which violates the basic assumption of error independence (Judge et al., 1985 pp.). An exact test that does not rely on assymptotic properties is the Goldfeldt-Quandt test. The results from this test show that there is no significant heteroscedasticity present (see appendix for results).

C. Implications of the Market Structure Analysis

In Chapter two, an hypothesis was presented that described the market for Alberta forest land owners as a

spatial monopsony, with the government acting as a monopoly seller of timber. As well, the results would seem to support the presence of transactions costs for both land owners and firms. These aspects of the market structure can now be placed within the context of the results as follows.

Land owners do not appear to be in possession of adequate information on opportunities available to them to become part of the wood supply. There are significant transactions costs involved in order to obtain this information, and it still does not allay the uncertainty involved in any investment to supply wood from their land.

In particular, land owners with some harvesting experience, are very sensitive to price, as it affects their returns to land. They will not look favourably on supplying wood over the long term if they must accept prices that are unattractive at the margin. Under the present market structure, there is no provision for land owners to bargain for wood prices, unless they are willing to incur significant transactions costs.

Forestry firms must also incur transactions costs under the present market structure, if they choose to obtain wood from land owners. The results do not provide any evidence on the nature of these costs. However, they do imply that firms presently purchasing wood from land owners, have maintained wood prices at low levels to reflect having to deal with many individuals, and the uncertain availability of their wood, over the long term.

The results show that real wood prices for aspen have declined over the last five years. Since conversion return is a function of price, firms must consider this an important incentive to land owners with potentially available wood supplies.

CHAPTER VI

Conclusions, and Implications for the Future

The nature of the sample results were such that they were generally consistent with most *a priori* expectations, and previous studies of forest land owners in other parts of Canada and other parts of the world. However, the inherent variability found in land owner characteristics was not entirely captured in the explanatory variables. Non-timber benefits from ownership of forest land is an obvious example, and likely, the lack of explanatory power in the variables used in the models of wood supply can be attributed to the inclusion of these non-timber benefits in an implicit sense only.

The results show a definite bias for land onwers choosing to liquidate their existing forest in favour of agricultural uses. The value of the existing growing stock is often used to subsidize investments in agricultural production. However land owners have found that it is often cheaper to forgoe the revenues from harvesting in favor of not incurring additional land clearing costs after logging.

The results have shown that land owners view long term investments in second growth stands as unreasonable. There is a perceived liquidity constraint in forest land investment whereby land owners do not consider the idea that the forest represents a capital stock not unlike investing in the stock market, or a term deposit. This is

augmented by considerable uncertainty and lack of information on the relative future expectations of performance for any given forest land investment. The possible reasons for market failure described in chapter II also support the inability of land owners to consider investment in forest land.

Despite this, the results do imply that owners of forest land act as rational economic agents, and thus even the relatively simple models of supply presented in this paper can account for their behavior. The model results indicate land owners exhibit positive supply responses to price, and net returns from harvesting. They also consider past returns from harvesting when making decisions on whether to supply wood in the future.

The survey data on land owner conversion returns, and the stumpage prices paid by the forest industry in Alberta are roughly equivalent. Thess data support the conclusion that land owners who are at present part of a secondary source of wood supply for firms, must accept prices for their wood that are about the same as stumpage prices set by the government.

Transactions costs may further limit the degree to which land owners can expect to receive competitive market prices for their fibre. Although the modelling results do not indicate the magnitudes of these transactions costs to firms, these costs represent a source of market failure that cannot be ignored without further investigation. The degree

of monopsonistic or oligopsonistic power that firms may have in markets for privately owned fibre is also a potential source of market failure, however further research is required in order to prove its existence.

As the demand for fibre grows in Alberta, there will be greater opportunity for land owners in many other parts of Alberta to consider supplying wood to firms. However, if land owners are to become an important part of the future wood supply, the results from this study would indicate that any policies directed towards them must consider the following points:

1. The general lack of information on the part of land owners on supply opportunities, forest management practices, market structures, forest inventory, and prices, would suggest that the wood supply from private land could potentially be enhanced if this information was available. Accessing this information must occur at a cost to the land owner, which must be weighed against the benefits from supplying wood.

2. Firms choosing to obtain wood from private land must consider the costs of dealing with a larger number of individuals for smaller parcels of fibre, versus the costs of obtaining wood from public land. To the extent that these transactions costs to firms are high, they will have that much less incentive to pay competitive prices to land owners for their wood.

3. Land owners are very responsive to price and returns

from harvesting in their decision to supply wood. This has important policy considerations, especially if firms are able to exercise monopsony power in purchasing wood. The histories of other areas of the world indicate that land owners can potentially benefit from pooling their resources to act as a single bargaining agent to determine prices.

4. As land owners are sensitive to stumpage price, the government can act to affect the supply of timber from private land as they act as monopoly sellers of stumpage.

5. Land owner objectives for the use of the forests show considerable variability. The results from this study have illustrated this in the high degrees of variabiltiy in both land and owner characteristics. Any policy directed toward enhancing the supply of wood from private land must consider the numerous potential benefits land owners may derive from their forests. While this study has not considered the decisions land owners make with regard to acounting for these non-fibre values, the results do indicate their presence.

There are a variety of potential programs that could be instituted in Alberta that would help to alleviate sources of market failure. Governments and/or firms may wish to consider providing information/marketing services to land owners. Such a service to land owners might also include information on forest management techniques, inventories, or how to locate professionals that could provide these services.

Tax incentives or programs that encourage land owners to manage their forests for wood supply may help to alleviate the perceived liquidity constraints to long term investments in private forest land. Programs such as these from other provinces in Canada may serve as examples for future programs in Alberta.

Land owners themselves may consider the benefits from pooling their wood supply in the form of a marketing board or similar agency. As mentioned previously it has been the history of other regions of Canada that the most successful marketing boards or land owner associations are those that are run and administered soley by the owners themselves. As such, many have become important, stable sources of wood supply for industry, and are able to receive competitive prices for their wood. This ultimately give their forest management efforts a much better chance of being profitable at the margin.

This study has identified a number of the more important considerations affecting land owners' decisions to supply wood in central Alberta. It is hoped that this will provide some guidance for both policies directed toward forest land owners, and further research into the numerous issues raised.

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APPENDIX

WOODLOT OWNER QUESTIONAIRE

This is a survey of land owners in central Alberta. The purpose of it is to obtain information on the histories of land owner's experiences with land that they own that is or was covered with trees. Very little is known about the feelings and activities that Alberta land owners have in connection with their trees/bush, and hopefully answers to these questions will help to provide some insights. All answers to these questions are completely confidential, and will not be used for any other purposes except those directly involved with the survey. Names of the land owners will not be included as part of the survey results.

Funding for the survey has been provided by Forestry Canada, and the results will be part of a research report for Forestry Canada, as well as part of the Master's thesis of Mark Messmer who is a Graduate Student, at the University of Alberta.

1. What is the total area of all land you own (acres or ha.)

2. What is the area of bush or forestland you own (acres or ha.)

Area leased or rented:_____

Area owned:_____

3. How much of you total land area is :

cultivated:_____

unimproved pasture_____

improved pasture_____

how many livestock and what

types:_____

_____

4. Please indicate roughly what percentages of the bush/forestland are:

TYPE	AREA	APPROX. AGE	RELATIVE HEALTH
Muskeg/swamp:			
Scrub/brush:			
Aspen:			
Poplar:			
Spruce:			
Pine:			
Spruce and Aspen:			
Mixed conifer/Decid:			
Other (please specify):			

5. Where is you permanent residence:_____

6.What is your general occupation:_____

7a.How many persons are in your household?_____

7b.Which of the following best desrcibes your household?

couple with children couple with no children one or

more unrelated single adults single adult with children

other(please explain):_____

8a.How long have you owned or leased the bush/forestland:_____

8b.How long has the bush/forestland been in your family:_____

9. How did you obtain it inherit or purchase or other(explain)_____

10. Have you added to or subtracted from the size of the bush/forestland:_____

_____

11a. Has anyone ever cleared trees from the bush/forestland area for logs or other forest products yes or no

If No, why:_____

11b. If yes to above, then: (for each occrrence)

year month area and volume by species sold to in what form price rec'd harvesting eqipment used

1._____

_____

2._____

_____

3._____

_____

4._____

_____

12.For each separate area listed previous, indicate what use was made of each area after it was harvested:

1._____

2._____

3._____

4._____

(options for above question): 1.used for grazing 2. put back into forest production 3. broken and put into crop production 4. other (explain)

13.If the bush/forestland was converted to grazing, how muchcould you receive if you rented this land for grazing purposes

(can also answer in dollars per ha. per year)_____

Also, how many A.U.M.'s would the land carry on a per acre basis:_____

(A.U.M.'s are animal unit months, a measure of grazing capacity)

14. If the land was converted to crop production what would be the annual rental value of this land (can answer in dollars per acre per

year):_____

also what would be the expected crop yield:_____

15. If these land areas were put back into forest production, when and what amounts of money were invested in these activities, and what were the nature of these activities:

_____

_____

_____

In addition to the above, please give a complete description of all activities that have taken place on the bush/forest land, including the type of activity, when it took place, and what costs were involved

_____

_____

_____

16. If these cleared areas were used for other purposes(question 12, item 4) what is the value of this use in dollars per (ha. or acre) per year.(opportunity rent rate)_____

17. If bush/forestland that you cleared and harvested trees from was used for other than forestry uses what would you consider to be a minimum acceptable price of timber that would have persuaded you to keep the land in forest

production

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18. If you knew that the returns to your land would be the same if you chose to keep it in forest production after it had been logged instead of using the land for other uses after logging, which land use would you prefer.

19.Do you feel that income from and investments in forest activities on your land are an important alternate source of income at the present time?_____
Will they be in the future?_____

20. Do you forsee harvesting trees as a long term addition to activites on your
land?_____
If yes, then how do you intend to harvest and manage them?_____

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21. What is your approximate annual net income,(net of all expenses, but before taxes):
less than 10,000 10,000 to 20,000 20,000 to 30,000 30,000 to 50,000 50,000 to 75,000 75,000 or more

22. What is the highest level of education you received

less than grade 12 grade 12 or diploma trade school

tech.school or college unversity or higher

23. What has been the percentage of your annual income obtained from the sale of wood products from your land ,on average over the last five years:_____

24.If forestry investments are not profitable to you, would you be more likely to consider pursuing forestry activities (fertilizing, stand cleaning, planting, thinning, insect and disease protection, etc.) if there were government assistance programs available e.g. tax relief, silvicultural or management services, guaranteed minimum prices for stumpage or wood sales, or other extension services:-_____

_____

25. What problems do you anticipate in growing, harvesting and selling wood?_____

_____

_____

26. What role do you forsee for government in helping you with these problems?_____

_____

_____

27. What percentage of your total forest land will always remain in an untouched state:_____

27b. What value per acre per year would you place on this land:_____

27c. What percentage of your total forest land would you keep for harvesting on an annual basis if you could receive:

$0.0 dollars per acre per year:_____

$5.0 dollars per acre per year:_____

$10.0 dollars per acre per year:_____

$15.0 dollars per acre per year:_____

$30.0 dollars per acre per year:_____

$50.0 dollars per acre per year:_____

$75.0 dollars per acre per year:_____

$125.0 dollars per acre per year:_____

28. Please provide any additional comments you think are useful:

29. If bush/forest land was cleared on your property, please indicate each occurrence:

Time: Year month and amount of land cleared and type of land cleared:_____

_____

29a. What was the cost of each of these operations? ($ per acre)

30. If bush/forest land was cleared, what are the main reasons why no timber was salvaged? (circle one below, but do not choose more than one, only the most significant reason):

1. No merchantable timber in the cleared bush.
2. Did not want to invest the time or money in doing it
3. Was not aware of how to sell/market timber or solicit for a contract to do the harvesting
4. At the time the bush was cleared, there was no available market for the trees
5. The money from the harvesting would not cover the increased costs of clearing land after it had been harvested
6. Other (explain):

OLS RESULTS FOR ALL VARIABLES

Dependent Variable: DPN

Observations: 38 Degrees of Freedom: 32

R-Squared: 0.895 Rbar-squared: 0.878

Residual SS: 4385.678 Std error of est: 11.707

Total SS: 41634.262 F(6, 32)=54.3567 P-value=0.0

Drubin-Watson Statistic: 1.662

Variable	Coefficient	Std. Error	t-stat.	P-value
constant	147.971004	12.314789	12.015716	0.000
SUPPLYF	1.111920	4.711806	0.235986	0.815
MERCH	-5.819807	0.665961	-8.738961	0.000
INCOME	-6.457866	8.479061	-0.761625	0.452
MARKET	0.830546	4.564254	0.181968	0.857
IMR	-157.641422	11.552149	-13.646069	0.000

Condition Indexes	Variance Proportions SUPPLYF	MERCH	INCOME	MARKET	IMR
1.00000	0.0045	0.0000	0.0986	0.0077	0.0444
2.65255	0.0183	0.0000	0.0982	0.0958	0.7891
2.92623	0.0661	0.0000	0.6606	0.2143	0.0813
5.03346	0.6829	0.0000	0.0068	0.6242	0.0280
41.74289	0.2283	1.0000	0.1359	0.0581	0.0572

GOLDFELT-QUANDT TEST

1ST OLS RESULTS

Observations:	15	Degrees Freedom:	13
R-squared:	0.056	Rbar-squared:	0.016
Residual SS:	8880.264	Std Error of Est.:	26.136
Total SS:	9408.377	F(2, 13)=0.7731	P-value=0.48

Variable	Coefficient	Std. Error	t-stat.	P-value
constant	73.576656	14.044533	5.238811	0.000
IMR	-57.247790	65.108322	-0.879270	0.395

2ND OLS RESULTS

Observations:	15	Degrees Freedom:	13
R-squared:	0.237	Rbar-squared:	0.178
Residual SS:	931.150	Std Error of Est.:	8.463
Total SS:	1219.777	F(2, 13)=4.0296	P-value=0.04

Variable	Coefficient	Std. Error	t-stat.	P-value
constant	29.207867	12.425771	2.350588	0.035
IMR	-31.219749	15.552467	-2.007382	0.066

$H_o: \sigma_t^2 = \sigma^2$ $H_a: \sigma_t^2 \neq \sigma^2$

$F_{test} = 931.50/8880.264 = 0.105$

$F_{table}(13, 13) = 2.60$

Conclusion: Since F_{test} is less than F_{table}, reject H_a.